A Map of Saltcedar Distribution on White Sands National Monument

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A Map of Saltcedar Distribution on White Sands National Monument[1]

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ABSTRACT

Natural Heritage New Mexico provides a map of the current distribution and estimation of stand density of saltcedar (*Tamarix chinensis*) within White Sands National Monument. Saltcedar covers approximately 1.8% of the park with the majority of stands (72%) classified as sparse having 1 to 10% cover of saltcedar. While some encroachment has occurred due to vehicular traffic along the main road into the park, most of the persistent stands extend from Lost River in the northeast section of the monument. Other areas of progressive recruitment lie at the margins of Lake Lucero and Lake Otero (Alkali Flat).

ACKNOWLEDGEMENTS

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ON THE COVER

Saltcedar within active dunes at White Sands National Monument.
Photograph by Charlie Jackson, 2008

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INTRODUCTION

Saltcedar (*Tamarix chinensis*) is widely distributed on White Sand National Monument (WHSA). This large shrub has the potential to radically transform the active dunes of the monument through vegetative stabilization and has altered the native plant communities surrounding the alkali flats of Lake Lucero. For example, saltcedar creates pedestals within the dunes and can change local wind patterns resulting in dune distribution patterns reflecting occurrences of invasive species (Bennett and Wilder 2009). In addition, invasion into arroyos, springs, and areas with shallow water tables has lowered water tables and degraded water quality (Bennett and Wilder 2009). Both aerial and hand-spray applications have been used within the monument to manage this rapidly spreading exotic. Although recent studies indicate saltcedar evapotranspiration (ET) rates are similar to other woody phreatophytes (Stromberg et al. 2009), there is no historical precedence within the park for large, dense stands of woody phreatophytes within any of the environments where saltcedar currently dominates (Figure 1).

To combat the spread of this aggressive exotic plant the park employs both aerial and hand-spray herbicide applications. Accordingly, there was a need for an accurate and precise saltcedar distribution map to be used in planning treatments and evaluating their effects. Given that total eradication is not expected, but rather a modicum of control the goal, the focus here was to identify those areas of highest concentration and density to facilitate effective and cost-efficient treatments. In addition, this map is designed to be compatible with a comprehensive vegetation map of WHSA currently being developed by Natural Heritage New Mexico (NHNM) for the park.

Figure 1. Salt cedar-dominated flat with fourwing saltbush, bounded by dunes to the northeast and southwest.

STUDY AREA

White Sands National Monument lies within the Tularosa Basin bounded on the west by the San Andres Mountains and the Sacramento Mountains to the east (Figure 2). The monument contains approximately half of the White Sands dune field with White Sands Missile Range and Holloman Air Force Base having stewardship of the remaining dune field. Within the monument is a portion of the ancestral, glacial Lake Otero, referred to as Alkali Flat, and Lake Lucero that form the numerous playas and alkali flats at the western boundary of the dunes and which are the source for the dune field. Lake Lucero is the topographically lowest area within the basin (1,185 m; 3,888 ft) and largest playa within the monument with water levels that fluctuate seasonally depending on inflow and evaporation (Bennett and Wilder 2009). We included the entire monument of 55,885 ha (138,095 ac) as our study area.

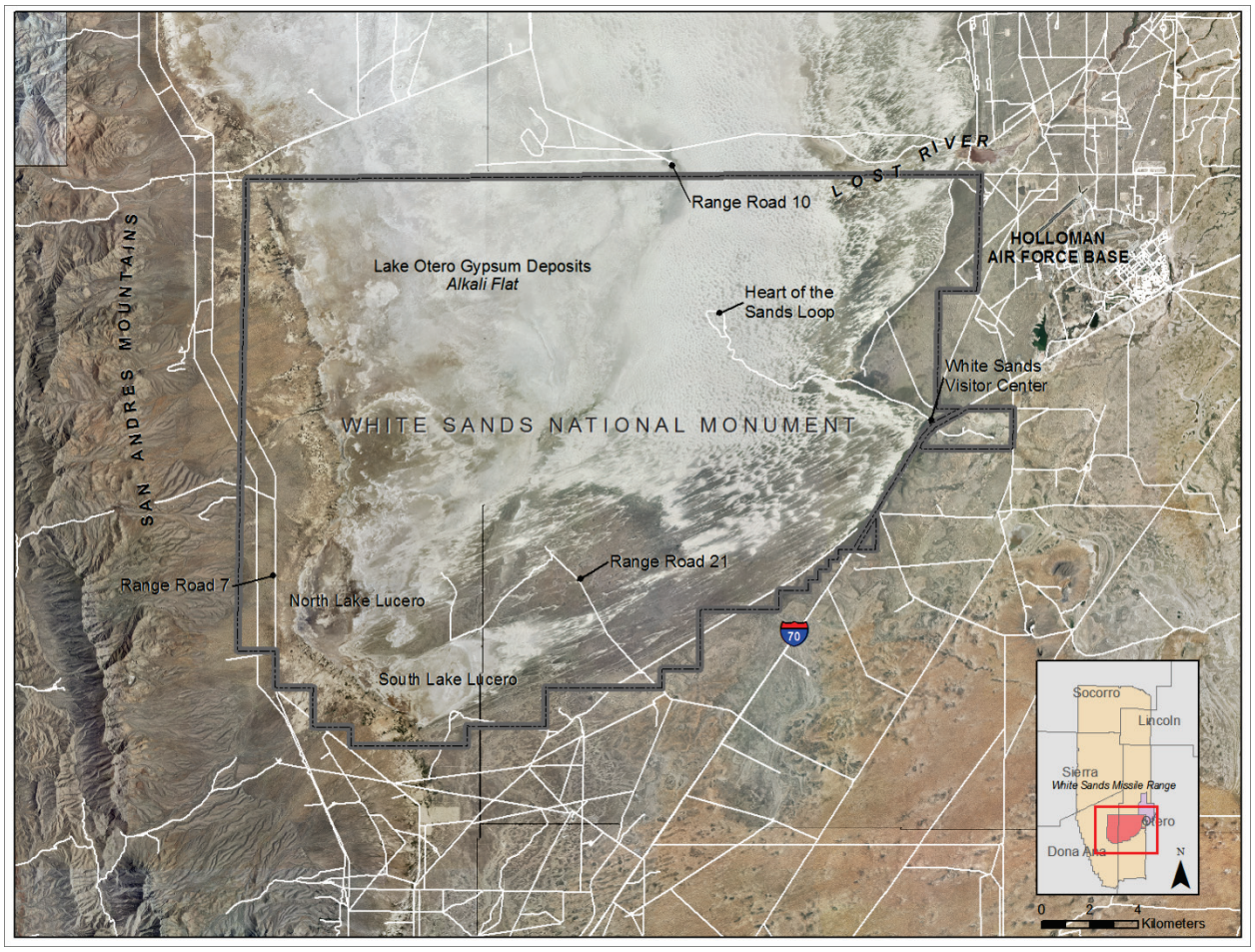

Figure 2. White Sands National Monument study area.

METHODS

Using recent (2005) digital aerial orthophotography as the base, Natural Heritage New Mexico applied a suite of image analysis, aerial photo interpretation, and GIS spatial analysis techniques along with field sampling to develop a digital map of saltcedar distribution on WHSA.

FIELD DATA COLLECTION

NHNM collected field data from 2007 to 2009 at 176 sites within the monument. Of these, 130 were targeted for the tamarisk mapping effort, comprising 96 plots and 34 separate GPS points at isolated trees or shrubs. The initial mapping effort in 2007 began with randomly selected field plots, however, the field efforts in 2008 and 2009 were guided by the ongoing mapping effort. Field sample points were selected and mapped in the GIS and provided to field crews to visit; these sites were a either (1) presumed to have a saltcedar component, or (2) considered vegetative cover types that were widely distributed and used to confirm there was no saltcedar component. When arriving at the pre-designated location, field crews could position themselves at the most representative site containing saltcedar or, in the cases where no saltcedar existed, the dominant species. Plots were approximately 400 m^2 (1,312 ft^2) and square, but occasionally other sizes and shapes were used to fit the structure of a community, especially along drainages where vegetation stands conformed to the channel shape. Data were entered on paper field datasheets and locations were recorded with a Garmen GPS Model 12 with +/- 10-m accuracy. The dominant plants for each strata (tree, shrub, forb, and grass) were recorded along with their percent relative abundance. Photos were taken from the center point of the plots in all cardinal directions. Data were entered into a database and quality checked, GIS layers developed, and photos archived and attributed with the field plot label. A total of 96 plots from 2007 to 2009 were entered into the database (Natural Heritage New Mexico 2010) and an additional 36 map points of isolated occurrences of single trees (saltcedars) were developed into a GIS with short descriptions (Figure 3).

IMAGE ANALYSIS

The saltcedar map was based on available natural color and color infra-red digital orthophotography acquired in June 2005 with a spatial resolution of one meter. Earth Data Analysis Center (EDAC) mosaicked the Digital Orthophoto Quarter Quadrangles (DOQQs) into a single file and added a Normalized Difference Vegetation Index (NDVI) as an additional band to emphasize areas of dense vegetative cover. The resulting image was a five-band file consisting of: visible blue, visible green, visible red, near infra-red, and the NDVI in bands one through five, respectively. The five-band file was analyzed using the object-oriented eCognition software (Definiens) to generate a first iteration of mapping polygons, creating more than 20,800 polygons. The initial set of polygons represented relatively homogeneous features within the monument. Each polygon was visually scanned into a GIS to determine whether the polygon represented a range of vegetated cover values that included saltcedar.

Image interpretation across the monument was variable due to the differences in albedo intensities and vegetative cover. To adjust for this factor, we would alter the image viewing properties by switching image-band combinations , try various histogram stretches, and adjust the brightness.

For example, the NDVI caused over-saturation within the inter-dune swales in the northeast of the monument where there was high contrast between the unstabilized dunes and the vegetated inter-dunes. Additionally, shadows caused by the dunes tend to have high NDVI values which give the appearance of high vegetative cover. Altering the display of the imagery helped the visual interpretation so that texture and color variation were further enhanced.

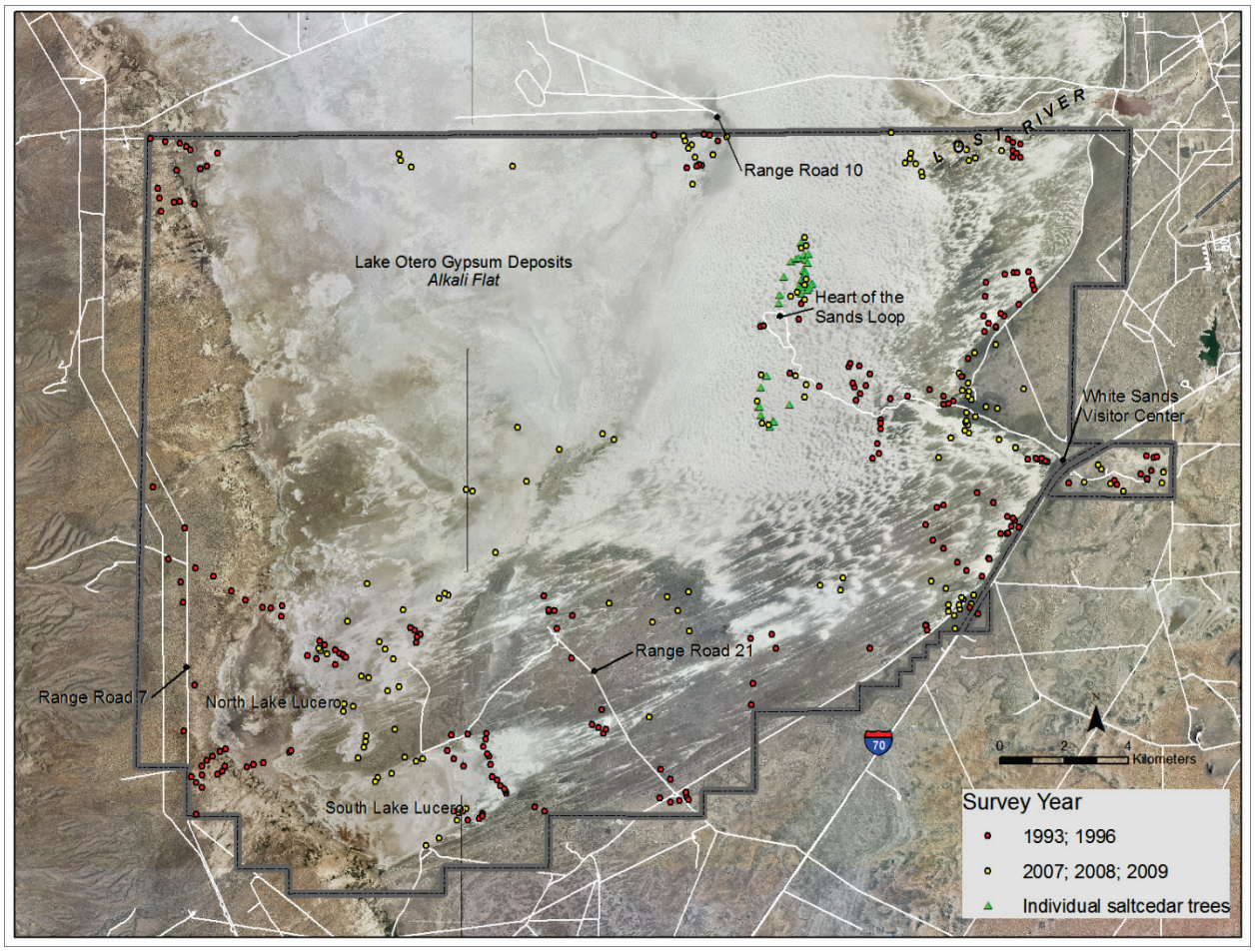

Figure 3. Natural Heritage New Mexico field plot locations.

We followed the protocols of the U.S. Geological Survey – National Park Service Vegetation Mapping Program (VMP) guidelines for content, precision and accuracy, i.e., a minimum map unit (polygon) size of 0.5 ha (1.23 ac) to be used at a 1:24,000 scale with saltcedar cover classes that follow the National Vegetation Classification standard of 1-10%, 10-25%, 25-60%, and > 60% aerial cover. These ranges in percent cover of saltcedar were used to attribute the polygons and, where needed, the eCognition polygons were spatially modified to represent the interpreters' judgement of the extent and percent aerial cover of saltcedar.

We used the field data plus legacy WHSA vegetation plots from the NHNM plot database (Natural Heritage New Mexico 2010), vegetation maps (Muldavin et al. 2000a, 2000b) and GIS field data

supplied by the monument to train the interpreters to recognize and differentiate saltcedar from other shrubs and trees that occupy some of the same topographic positions as saltcedar.

We did not distinguish dead from live trees; however, field data was useful in helping us calibrate our assignments of density. For example, where chemical treatment had occurred, the surveyor indicated whether regrowth was occurring and with the addition of plot photos, we adjusted what typically appeared to be much greater densities to reflect on-ground estimations.

RESULTS

SALTCEDAR MAP OF WHITE SANDS NATIONAL MONUMENT

Saltcedar covers approximately 987 ha (2.439 ac) or 1.8% of the monument (Figure 4). The classification category 'Scattered Trees' comprises the greatest percent cover of saltcedar stands within the monument followed by Sparse, Open, and Closed Stands (Table 1). The average stand size is .88 ha (2.17 ac). The largest stand is 101 ha (250 ac), a nearly contiguous area of scattered trees at Lost River in the northeast portion of the monument. Elevation ranges of 1,185 to 1,190 m

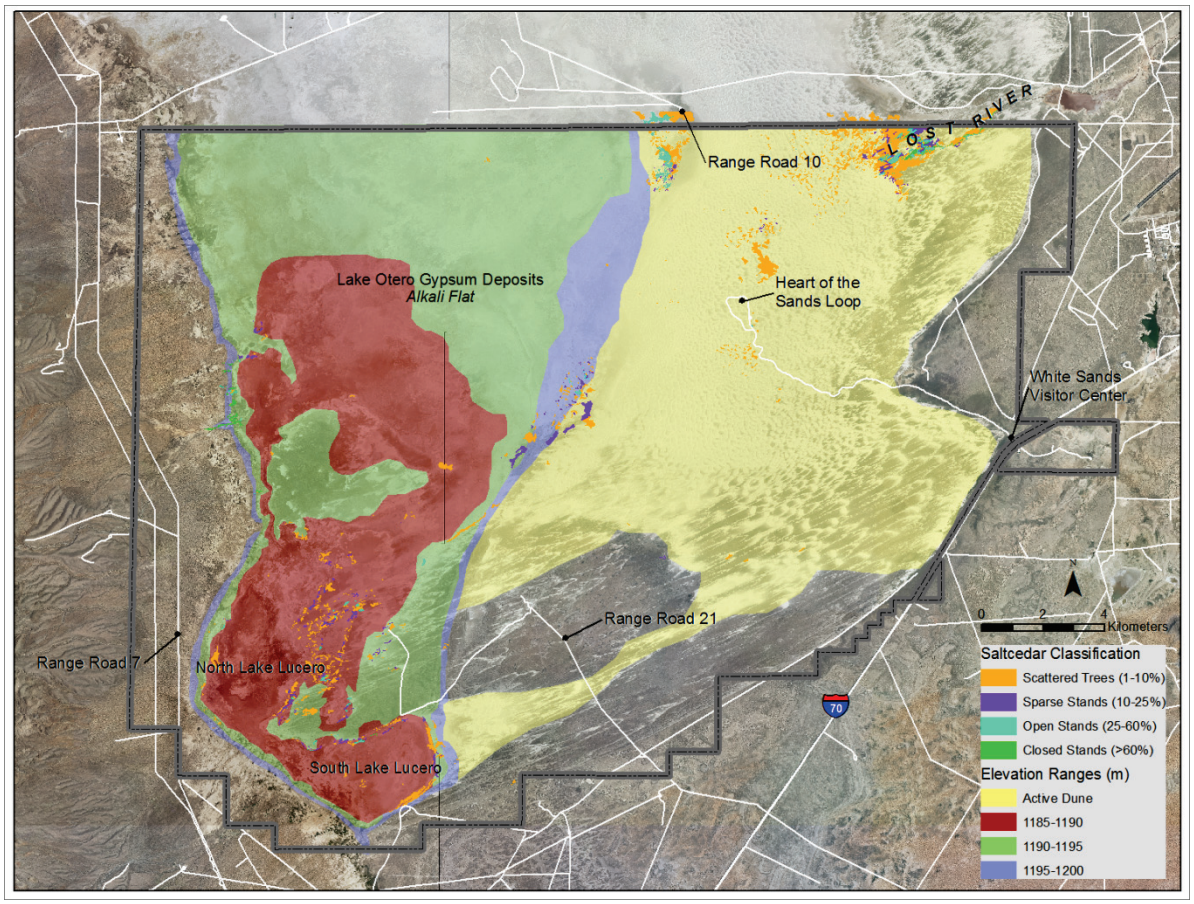

Figure 4. Distribution by stand cover value of saltcedar within the monument.

(3,888 to 3,904 ft) indicate much of the current maximal extent of both North and South Lake Lucero are circumscribed by relatively narrow stands of saltcedar. Two distinct locales, one at the center of the monument and another at the north-central monument boundary, appear to lie at the boundaries of the Lake Otero (Alkali Flat) gypsum deposits. Transportation along the Heart of the Sands Loop road is likely responsible for invasion into the main body of the active dunes, while Lost River is the source at the eastern margin, where saltcedar has colonized into the interdune areas where the river is truncated by the sands.

Table 1. Saltcedar cover scale values at White Sands National Monument.

Cover Code	Cover Description	Polygon Count	Ha Minimum	Ha Maximum	Ha Average	Ha Total	% Total Saltcedar
1	Scattered Trees (1-10%)	652	0.01	101.05	1.09	712.02	72.1%
2	Sparse Stands (10-25%)	189	0.01	12.75	0.79	148.39	15.0%
3	Open Stands (25-60%)	111	0.01	15.13	0.85	94.27	9.5%
4	Closed Stands (>60%)	42	0.01	6.31	0.79	32.99	3.3%
	Saltcedar Total	994				987.67	
	WHSA Study Area					55885.48	

The products developed under this project will be placed onto a CD and delivered to the park and will include: digital copy of the report, an Excel spreadsheet of the plot data, and GIS layers in ArcGIS file geodatabase format. The GIS layers include the point locations of plots, incidental single tree locations, and the saltcedar polygon map.

DISCUSSION

The highest concentration of saltcedar occurs in lowland areas that are periodically saturated from accumulated water due to storm events. Typically, these were at the margins of Lake Lucero and the Lake Otero (Alkali Flat) in the southwest part of the monument, and in the Lost River drainage in the northeast part. Lost River appeared to have the highest concentrations and densities of invasive encroachment, followed by the northern boundary of the monument and WSMR along Range Road 10, which lies at the northeast margin of Lake Otero (Alkali Flat). Substantial re-sprouting after chemical treatments within the Lost River area is also occurring. Invasion into the active dune field and interdune regions may be the result of invasives inadvertently transported by vehicles using the Heart of the Sands Loop road, and possibly Range Road 10. Additionally, the close proximity of the dunes to Lost River may be a source for the eastern region of the dunes, although wind patterns throughout the year are predominantly easterly, away from dunes.

We believe we could reasonably differentiate shrubs such as fourwing saltbush (*Atriplex canescens*) and rosemary mint (*Poliomintha incana*) from saltcedar. However, cottonwood (*Populus deltoides*), skunkbush sumac (*Rhus trilobata*), and honey mesquite (*Prosopis glandulosa*) were more problematic. Since honey mesquite was isolated to the western, more upland portion of the monument, we could discount what appeared to be saltcedar. However, within the drainages

entering the alkali flats along the western edge, there may be areas we identified as saltcedar that may be dominated by either honey mesquite or alkali sacaton (*Sporobolus airoides*).

Areas that had been chemically treated were also problematic since we had no information as to when the treatment occurred, relative to the acquisition date of the aerial orthophotos. Much of the high vegetative response in chemically treated areas could also be due to spring ruderals colonizing the treated areas along with the regrowth of extant treated stands. Field data and photos were highly effective in driving attribution of density cover values.

No formal accuracy assessment was conducted for the map. There was a period of informal testing mid-project by park personnel that served as proof-of-concept on the photo-interpretation rule base and line work for the map. The accuracy of the map will be formally tested when this saltcedar GIS is integrated into the comprehensive vegetation map for the monument currently being developed by NHNM.

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